SYMBOLIC LOGIC (HS30068)

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IIT KHARAGPUR

Module 1

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Introductory lecture:

- What Logic is
- What Reasoning is, and its link to Logic
- Kinds of Logic
- Western and Indian Logic

Q. What is logic?

Logic is:

- A systematic study of Reasoning

- It is sometimes called: Art of Reasoning

Art: Skills to learn, how to do it best

►So, Logic teaches us reasoning skills, how to do better reasoning

- It is sometimes called: Science of Reasoning

- **Science**: A systematic study with Principles:

So, Logic is a systematic study which provides the Principles or Rules of Correct Reasoning

Logic is both an art and a science of reasoning

Q. What is Reasoning?

Reasoning: A basic cognitive activity. We acquire knowledge through it.

Nature of knowing is not public. Private. It occurs in the mind. Or, in the brain.

So, the subject matter of logic is difficult: A systematic study of a process of thinking.

How is reasoning different from the other cognitive activities?

Reasoning is a process of knowing that enables one to **go beyond the information given** (a cognitive act), and **create knowledge.**

This is the special feature of reasoning.

To stay **within** what is given in knowing: As in the case of knowledge from sensory organs.

Example: In case of tasting a food, the knowledge is from what is presented to the senses, e.g. to the tongue.

To **go beyond** what is given: Reasoning creates knowledge.

For example:

You come to meet me, but

- **See a lock on my door ➔?**
- **See a latch on my door ➔?**

What you **see** is a lock, or a latch: Visual knowledge

But by reasoning you **know** more than that. That knowledge is created by your reasoning.

The gap between what you **see** and what you **know** is filled up by inferences: **Acts of reasoning**

Reasoning creates knowledge beyond what is given.

But, because it goes beyond simple observation, reasoning is not a 100% error-proof process.

Yet, we must rely upon reasoning if new knowledge has to be created.

That is why there is need for a subject that would help us to reasoning correctly, avoiding the errors.

Logic is that study of reasoning: The Art and Science of reasoning

“The most formidable weapon against errors of every kind is Reason. I have never used any other weapon, and I trust I never shall.”

-Thomas Paine-

(1736/37-1809)

[Political thinker and activist, influenced American revolution against England]

►Trust on reason to avoid errors of reasoning and thinking

Etymologically: The term **'Logic'** is Derived from the term Greek term ***Logos***

Logos (Greek): Has many meanings.

Aristotle used it to mean: **A reasoned discourse, body of knowledge**

So, etymologically, by being derived from Logic: Logic is a **reasoned discourse, or a body of knowledge governed by reasoning.**

But let us remind ourselves what the subject matter of Logic is: **Reasoning**.

► So, Logic Is a reasoned discourse about reasoning.

Q. Does Logic deliberate on Reasoning as applied to some area of knowledge?

Other studies, also derived from 'Logos', concern themselves with specific areas of knowledge:

- **Bio*logy***
- **Socio*logy***
- **Geo*logy***

The Prefix indicates their subject domain

Example: **Socio-*logy* is *logos* about Society.**

Note: The name 'Logic' carries no such indication about the area covered.

This does NOT show Logic has no specific content.

Instead, it shows: Logic is **"Topic-neutral"** (Gilbert Ryle)

It is a **"universal tool":** Applicable wherever reasoning is used.

So, the answer: **Logic is a systematic study of reasoning itself, and is applicable wherever reasoning is used.**

Q. What is its tool to study reasoning? What is its tool to detect the errors of reasoning and to propose rules for correct reasoning?

Answer: Reasoning is its own tool.

Q. Does logic teach us **how to reason**?

Ans: NO. We reason *whether we know logic or not*. Logic only teaches us ***how to reason correctly***.

The study of logic is supposed to help us learn how to distinguish ***good reasoning*** **from** ***bad reasoning*****.**

It provides us:

- The rules
- The criteria
- The methods for correct reasoning.

Q. What is the value of studying logic?

Two kinds of answers:

(a)**Instrumental value**: To have value only as an important tool or instrument.

A tool or instrument: It is used for some other purpose. A tool has value only until it serves the purpose. E.g. A pen.

Aristotle: Called logic *Organon*, an indispensable **tool** for any other systematic thinking. (as is mathematics). Many other Western thinkers also saw instrumental value of Logic: Logic is an **universal tool**

Nyāya (Indian Logic) System, Medieval European Logicians: It is a **tool,** which enables us for correct way of thinking, and cogent public speaking. It teaches us to avoid fallacies.

Another kind of answer:

(b) Intrinsic value: Value in itself.

Studying logic has value in itself. It clarifies thought, steers us to truth, teaches us to avoid conceptual errors.

Stoic Logicians: Logic is integral for thinking, makes us better thinkers, better at language use.

What does it mean to use reasoning logically?

- Finding/ providing reasons to explain *a claim: Why so*
- Finding / providing reasons to justify / support *a claim: Why must we accept it*
- Finding / providing reasons to reject *a claim: Why it must not be accepted*
- Finding / providing reasons to evaluate *a claim: Lets see if it is so*

More common example of logical reasoning: In Logical problem solving or in **Logical puzzles**

►Logical puzzles: These are problems or puzzles which are to be solved by using logical reasoning

Famous logic puzzle person: Charles Lutwidge Dodgeson (1832-1898), English Logician, Mathematician,

aka Lewis Carroll : Author

■Alice in Wonderland
■Through the Looking Glass

Recent famous logic puzzle author: **Raymond Smullyan,** has several books on Logic Puzzles

He has a series of famous **Knight** and **Knave** Puzzles

Sample of logical puzzle :

Puzzle 1

There are only 2 kinds of people in this kingdom: Knights and Knaves

►**Knights always tell the truth**

►**Knaves always lie**

You are a newcomer. You meet two persons, A and B.

A says: **At least one of us is a knave.**
B remains silent.

Is A a Knight or a Knave?

Solution to puzzle 1: **A is a Knight**.

The logic or the reasoning explained:

1. If A is a knave, then it is false that ‘At least one of us is a Knave’ (P).

But P would be false if and only if both A and B are Knights.

But that is impossible. Because then A would be a Knight and Knights always tell the truth. Then A would **not** be saying: ‘At least one of us is a Knave’

So, A cannot be a knave. A must be a Knight.

2. If A is a Knight, then it is true that P. Then B must be the Knave.

Solution: A is the Knight, B is the Knave.

►Note: The nature of the puzzle and its solution are essentially logical. It demands the use of reasoning correctly to arrive at the solution. The solving also requires logical analysis of the situation.

Classification of logic can be done in many ways:

1. **Formal Logic and Informal Logic**
2. **Indian Logic and Western Logic**
3. **Deductive Logic and Inductive Logic**
4. **Conventional Logic and Non-conventional Logics**

Formal and Informal logic

Informal Logic: The logic which teaches us how to **reason well in real life situations; it promotes critical thinking**

LOGIC FOR Real Life REASONING: It attempts to assess, analyze and improve reasoning in everyday language.

Example: In personal conversations, advertising, political debate, legal arguments, mass media reporting.

Aim of this logic: To enable improvement of public reasoning, and to instill the habit of critical inquiry

So, if you ask: WHAT IS LOGIC?

THE ANSWER from INFORMAL LOGIC is:

- **A systematic study of reasoning, or of inferences**
- **A tool for reasoning well in real life situations**
- **A tool for promoting critical thinking**

Formal Logic

Formal Logic: Works with abstract, **Logical Forms.**

Formal Logic typically has three components:

- **Syntax & Language**
- **Semantics**
- **Deductive System/ Proof Theory**

In this course: Only Formal Logic will be taught. And that too only Western logic.

So, If you ask WHAT IS LOGIC?

The answer from FORMAL LOGIC is:

Logic is a 'form' based or formal study. It studies statement forms, argument forms, and teaches us to distinguish correct reasoning from incorrect reasoning.

A formal logic typically has three components:

- Syntax & Language
- Semantics
- Deductive System/ Proof Theory

Aim: To prove or demonstrate formalized reasoning: In symbolic abstractions, formulae

Western and Indian Logic

Indian Logic is a distinctly different logic than the western logic.

Indian ancient Texts from 6th BCE onwards are available on Indian Logic: *Hetu Vidya*

Two major schools of Logic were there:

1.Anvikshiki (the Science of Inquiry) and

2.**Tarka** (Argumentation) schools of logic

Every major philosophical and theoretical traditions used logic to establish its claim, and to refute the claim of the opponents:

- Among the Hindu schools, the **Nyaya-Vaiseshika** Tradition of logic
- **Buddhist logic**
- **Jain Logic**

Classical proponents:

Acharya **Nagarjuna** (150-250 CE)

Dignaga (480-540 CE): Indian deductive logic,

Dharmakirti (7^{th} CE): Taught at **Nalanda**

Vasuvandhu, **Gautama**, etc

Famous Indian Logic Texts:

- **Nyayasutra**
- **Vaisesika Sutra**
- **Pramanavarttika**
- **Mulamadhyamika karika**, etc.

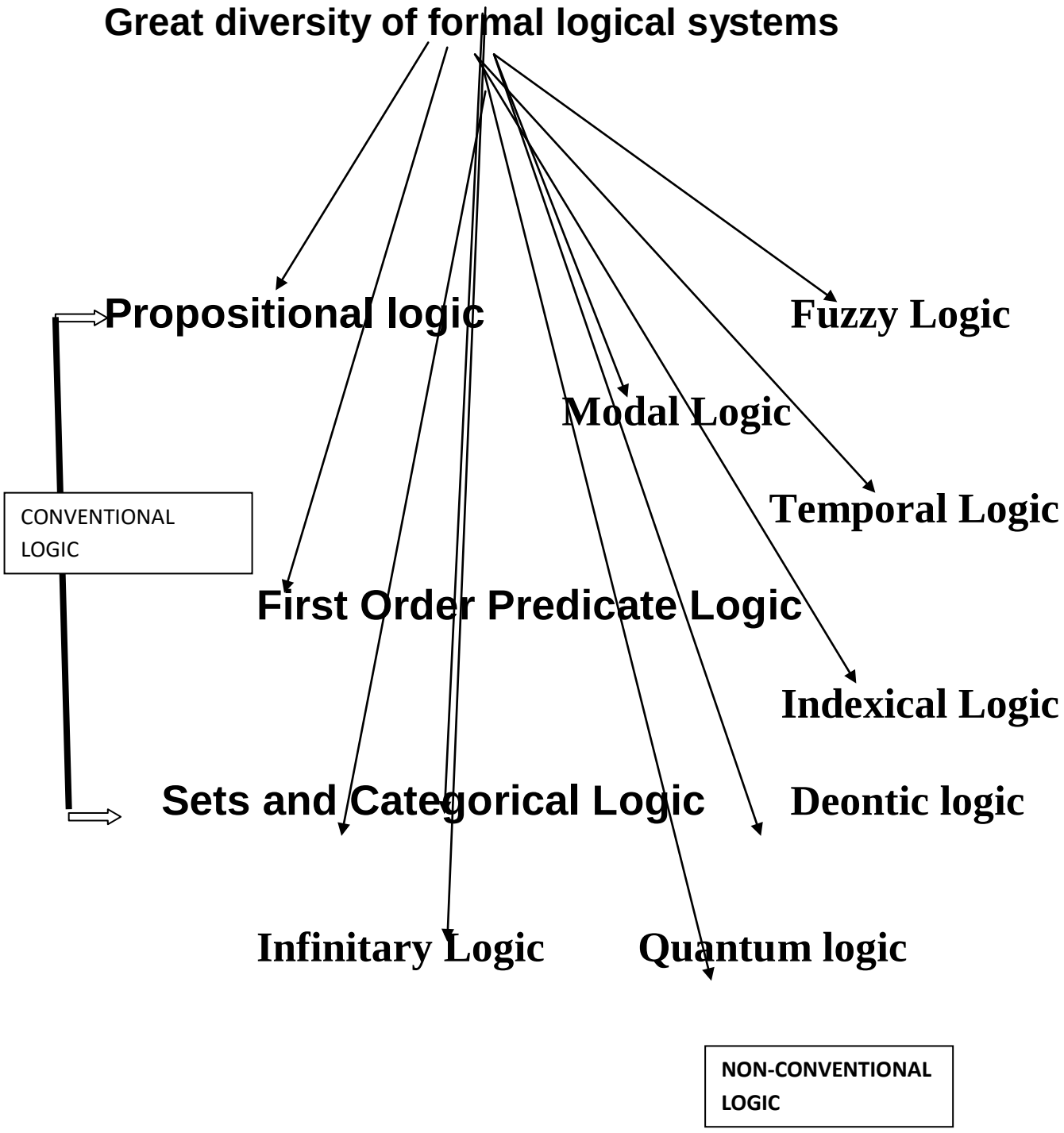
Logical Principles used: Many common inference principles used, e.g. Modus ponens, principle of non-contradiction, *reductio ad absurdum* (Prasarga)

Indian syllogism of Nyaya System: 5 membered structure of **Anumana**

Jain logic: Theory of conditioned predication **(Syadvada)**

Navya-Nyaya: Neo-logical tradition of Gangesa

Conventional and non-conventional Logic:



Laws of Thought

Conventional logic believes in **Laws of thought: Principles that govern human thinking**

Laws of Human Thinking

Recent debates: Why call them 'Laws'? Are they innate, or acquired?

Aristotle (384-322 BCE), *Prior Analytics*: First extant logical system in the West. He believed in LAWS of THOUGHT: Certain basic principles which guide our thinking

- Law of Identity: A is A
- Law of Non-contradiction: Nothing can be both A and not-A.
- Law of Excluded Middle: For any x, it has to be either A or not A; it cannot be neither A nor not-A.

George Boole (1815-1864), *Laws of Thought*: First mathematical treatment of logic. An algebra with logical entities.

Also believed in Laws of Thought.

Difference: Twenty-two centuries.

George Boole: These laws are inseparably connected with how human intellect is constituted.

Boole's addition:

►Index Law

►Law of Commutativity of conjunction